NTK/KW/15/7358/7363

Faculty of Engineering & Technology

Fourth Semester B.E. (Electronics)/ET/EC (C.B.S.)

Examination

ELECTROMAGNETIC FIELD

Time : Three Hours] [Maximum Marks : 80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Solve **SIX** questions as follows :

Question No. **1 OR** Question No. **2**

Question No. **3 OR** Question No. **4**

Question No. **5 OR** Question No. **6**

Question No. **7 OR** Question No. **8**

Question No. **9 OR** Question No. **10**

Question No. **11 OR** Question No. **12**

(3) Due credit will be given to neatness and adequate dimensions.

(4) Assume suitable data wherever necessary.

(5) Diagrams should be given wherever necessary.

(6) Illustrate your answers wherever necessary with the help of neat sketches.

1. (a) Transform the vector field $\overline{F} = 2\cos\theta\,\bar{a}_r + \sin\theta\,\bar{a}_\theta$ in Cartesian co-ordinates and evaluate it at point P(4, –3, 2). 7

(b) Find $\overline{E}$ at P(1, 5, 2) in free space if a point charge of 6 μc is located at 2(0, 0, 1), a uniform line charge of 180 nc lies along x-axis and a sheet of charge equal to 25 nc/m² lies in the plane z = –1. 6

OR

2. (a) State and explain Coulomb's Law. 4

(b) Given that $\overline{D} = \frac{5r^2}{4}\bar{a}_r$ in spherical co-ordinates. Evaluate both sides of divergence theorem for the volume enclosed by r = 1, r = 2. 9

3. (a) State and explain Biot-Savart's-Law. Derive the expression for $\overline{H}$ due to infinite current filament carrying current in $\bar{a}_z$ direction. 9

(b) Find $\overline{H}$ at P(2, 3, 5) in Cartesian co-ordinates if there is an infinitely long current element along y-axis. The current is 50 A along positive y-direction. 5

OR

4. (a) Starting from the Law of conservation of charges, derive the continuity equation $\nabla \cdot J = -\frac{\partial \rho v}{\partial t}$. 6

(b) Explain the following terms (any TWO) :—

(i) Scalar and vector magnetic potential.

(ii) Ampere's circuital law.

(iii) Magnetic flux and flux density.

(iv) Conduction and displacement current density. 8

5. (a) State Maxwell's equation for static electric and steady magnetic field in integral and point form. 4

(b) State Faraday's Law of electromagnetic induction. Apply Faraday's Law to closed path and derive Maxwell's IVth equation for time varying field. 5

(c) Select the value of K so that the following pair of fields satisfy Maxwell's equations in the

region where $\sigma = 0$ and $\rho_v = 0$.

$\bar{E} = (kx - 100t)\,\bar{a}_y$ V/m

$\bar{H} = (x + 20\ t)\ \bar{a}_z$ A/m

if $\mu = 0.25$ H/m and $\varepsilon = 0.01$ F/m. 4

OR

6. (a) Write a note on conduction current and displacement current densities. 5

(b) In a region where $\sigma = 0$, $\varepsilon = 2.5\ \varepsilon_0$, $\mu = 10\ \mu_0$, determine whether following pair of field satisfy Maxwell's equation :

$\bar{E} = 100 \sin(6 \times 10^7 t) \sin z\ \bar{a}_y$

$\bar{H} = -0.1328 \cos(6 \times 10^7 t) \cos z\ \bar{a}_x$. 8

7. (a) Show that characteristic wave impedance of a uniform plane wave in any medium is given by :

$$\eta = \sqrt{\frac{jw\mu}{\sigma + jw\epsilon}}.$$ 8

(b) A 9375 MHz uniform plane wave is propagating in polystyrene. If the amplitude of electric field intensity is 20 V/m and material is assumed to be lossless. Find :

(i) the phase constant

(ii) the wavelength in polystyrene

(iii) the intrinsic impedance

(iv) the velocity of propagation

(v) the propagation constant

(vi) the amplitude of magnetic field intensity.

For polystyrene $\varepsilon_R = 2.56$, $\mu_R = 1$. 6

OR

8. (a) Write a short note on 'Brewster's angle'. Derive an expression for Brewster's angle θ_B. 8

(b) Explain the following terms :—

(i) Skin Depth

(ii) Poynting vector. 6

9. (a) A rectangular waveguide has cross section dimensions a = 7 cm, b = 4 cm. Determine all the modes which will propagate at a frequency of :

(i) 3000 MHz

(ii) 5000 MHz. 6

(b) Why TEM wave does not exist in rectangular waveguide ? 3

(c) Explain how rectangular waveguide acts as a high pass filter. 4

OR

10. (a) Show that the geometric mean of phase velocity and group velocity is equal to velocity of light. 7

(b) Derive an expression for wave impedance for TE waves propagating between rectangular waveguides. 6

11. (a) Explain the concept of retarded potential. 5

(b) A monopole antenna of height 10 cm operated at a frequency of 300 MHz and is situated above the ground. Find its radiation resistance. 4

(c) Explain what is 'Induction field' and 'Radiation field'. 4

OR

12. (a) An antenna has a radiation resistance of 72 Ω, a loss resistance of 8 Ω and power gain of 12 dB. Determine antenna efficiency and its directivity. 7